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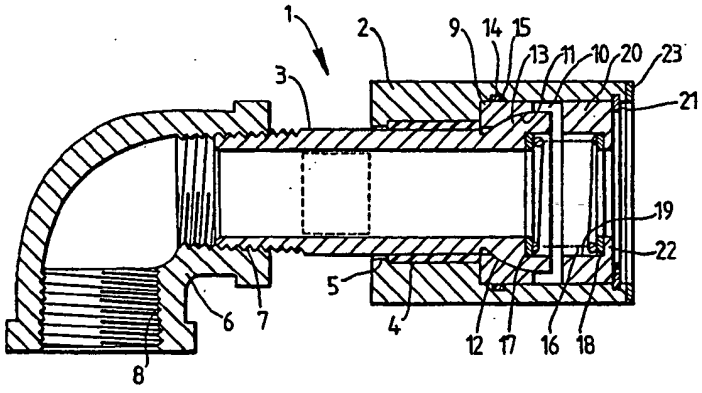
(54) **Liquid-tight rotary pipe joint**

(57) A rotary joint, in this case for use in a liquid-cooled roll for a continuous casting system employs a housing 2 having a coaxially arranged sleeve 3, with sealing between the housing and the sleeve achieved by means of an annular seal 9 non-rotatably fixed with respect to the housing but provided with a concave part-spherical sealing surface 11 to conform with a convex part-spherical sealing surface 12 on the sleeve, the two part-spherical surfaces 11, 12 of the annular seal and the sleeve being held in contact with one another by means of a helical compression spring 16. The compression spring bears against a releasable retaining member 20, held in place by a circlip 21, to facilitate repair of the rotary joint.



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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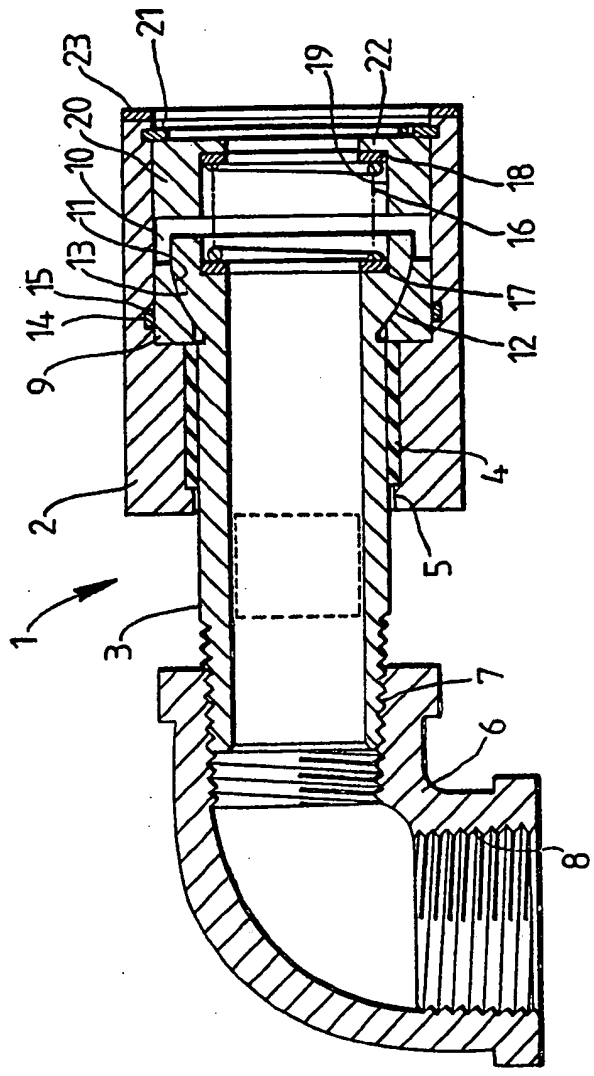

SPECIFICATION

Liquid-tight rotary pipe joint

The present invention relates to a liquid-tight rotary pipe joint.

There are many applications in which a joint between two conduits is to be such as to permit relative rotation between the conduits about an axis which is coaxial to the conduits at the joint. For example in continuous casting plant, or similar applications, where a heat transfer medium, for example a coolant, is to be introduced into and removed from a rotating roll it is advantageous for the coolant to be introduced at one end of the roll along a passage coaxial with the axis of rotation of the roll and to be removed along a similar coaxial passage at the opposite end of the roll while the roller is rotating and carries one of the conduits to be joined at the rotary joint and the supply and discharge pipes for the coolant are substantially stationary and define the other of the conduits to be joined at the joint.

In accordance with the present invention we provide a rotary joint comprising a housing; a sleeve disposed within said housing and supported so as to permit relative rotation between the housing and sleeve about the longitudinal axis of the sleeve; an annular seal disposed within said housing and held against rotation with respect thereto, said seal having a concave part-spherical internal surface; a part-spherical convex external surface on said sleeve positioned to engage with said part-spherical concave surface of the seal and having substantially the same radius of curvature; means for connecting an end of said sleeve to a first conduit; means for connecting said housing to a second conduit; and means resiliently urging said sleeve for axial movement with respect to said housing in a sense which presses said part-spherical convex surface of said sleeve into firm contact with the part-spherical concave surface of said annular seal.

Preferably the seal has a cylindrical external surface sealed with respect to a conforming cylindrical internal surface of said housing by means of a yieldable sealing member.

Advantageously a low friction bushing is provided in said housing for supporting said sleeve for rotation about its longitudinal axis.

In order that the present invention may more readily be understood, the following description is given, merely by way of example, reference being made to the accompanying drawing in which the sole figure is a longitudinal sectional view of a rotary pipe joint in accordance with the present invention.

In Figure 1, the rotary pipe joint 1 comprises a housing 2 which is of cylindrical form and has a bore freely rotatably receiving a sleeve 3 coaxially therewithin. Rotatable support for the sleeve 3 is afforded by a bushing 4 of impregnated steel construction known by the trade name "DU". The bushing 4 is held captive in the housing 2 by means of a radially inwardly extending bead 5 of the housing.

In this particular embodiment of rotary joint, roll in a continuous casting system, an elbow 6 is attached to the sleeve 3 at the end which projects from the housing 2 by means of cooperating tapered threads 7 between the elbow and the sleeve. Another similar tapered thread 8 is formed at the opposite end of the elbow.

The sealing components of the rotary joint are all encased within the rotary housing 2 and essentially comprise a hard annular seal 9 received within an enlargement 10 of the bore in the housing and having a part-spherical concave sealing surface 11 which conforms closely with the convex part-spherical outer sealing surface 12 of an enlargement 13 of the sleeve 3. Because of the spherical nature of the concave surface 11 and the convex surface 12, it would strictly speaking be possible for the sleeve 3 to be able to swivel about a transverse axis passing through the centre of curvature of the part-spherical surface 12 but in practice this swivelling movement will be prevented by the rotatable support constraint offered by the bushing 4. The annular area of contact ensured between the conforming concave and convex surfaces 11 and 12, respectively, instead affords a reliable sealing action between the enlarged end 13 of the sleeve 3 and the annular seal 9.

The annular seal 9 is dimensioned externally so as to be a tight fit in the enlargement 10 of the bore in housing 2 and passage of liquid between the external cylindrical surface of the annular seal 9 and the wall of the housing bore enlargement 10 is prevented by an O-ring seal 14 squashed in an appropriately formed rectangular cross-section groove 15 in the housing wall.

Sealing engagement of the concave and convex surfaces 11 and 12, respectively, is assisted by means of a helical compression spring 16 disposed in stressed condition between, on the one hand, a thrust ring 17 within the enlarged end 13 of the sleeve 3 and another similar thrust ring 18 received within a stepped recess 19 in a cylindrical retainer 20 which is held in place in the housing 2 by means of a spring circlip 21 received in a suitably formed groove in the wall of the housing bore enlargement 10. The two thrust rings 17 and 18 are formed of hard brass and the retainer 20 is of stainless steel in order to resist any corrosive tendency of liquid flowing within the sleeve 3 and confined by the seal. The thrust ring 18 is, as illustrated, backed up by a shoulder 22 formed at the step of the bore 19 in the retainer 20.

Since the housing 2 is to be mounted at one end of a conduit from which or into which liquid flow past the sealing components 9-14 of the rotary joint, the housing 2 is shown in the drawing as including a gasket 23 to seal the right-hand end face of the housing against a flat wall at the end of this other conduit (not shown). In the case where the rotary joint is to be used in a continuous casting machine, the housing 2 may if desired by clamped externally against the end of a roll through which coolant admitted by way of the rotary seal 1 is to pass, the cylindrical housing 2 being mounted coaxially with the roll so that upon rotation of the roll the housing 2 rotates while the sleeve 3 and the elbow 6 illustrated in the drawing remain stationary or are free to pivot

pipe to be attached on the elbow 6 by way of threads 8.

The annular seal 9 is formed of polytetrafluoroethylene with a filler of sintered bronze dispersed throughout the body. For example the composition may comprise 60% bronze. Other fillers may instead by used, and it is also possible to use mineral fibre reinforcement in the seal. The use of polytetrafluoroethylene as the sealing material is particularly advantageous as it is less brittle, and thus offers higher resistance to shock loads, than carbon-based seals.

The sleeve 3 is formed of mild steel with a layer of electroless-nickel for corrosion protection purposes. Alternatively chromium plated mild steel, or stainless steel may be used. Also, a resin-bonded layer of molybdenum disulphide is applied to the sleeve 3 to reduce even further the low coefficient of friction between the convex surface 12 and the exposed polytetrafluoroethylene concave surface 11 with which it is in sliding contact.

The material of the annular seal 9 may alternatively be a carbon based seal composition, or a polyimide based seal composition, and other possibilities for the friction-reducing coating on the surface, at least over the enlarged portion 13 of the sleeve 3, include a polytetrafluoroethylene-based coating.

One of the advantages of the rotary seal in accordance with the present invention is the use of replacing the annular seal and otherwise repairing the joint after prolonged use. On the assumption that the housing 2 is recessed into a suitably formed cylindrical socket in a roll (not shown) of a continuous casting machine, the first stage of disassembly will be to remove the elbow 6 from the threaded end of the sleeve 3 by undoing the tapered threads 7. Then access can easily be gained to the clamping means (not shown) holding the housing 2 in place in the socket in the end of the roll.

To facilitate dismantling of the elbow 6 and the sleeve 3 from on another, the sleeve 3 has external flaps to enable it to be gripped while the right angled configuration of the elbow 6 is itself readily capable of being held in order to facilitate unscrewing of the tapered threads 7.

It is not absolutely essential for the clamping means to be undone only after removal of the elbow 6, as the main purpose of removing the elbow 6 is to facilitate withdrawal of the sleeve 3 in the rightward direction from the housing 2 to allow renewal of the annular seal 9 after removal of the housing 2 from its socket in the roller.

Once the housing 2 and the sleeve 3 have been removed as a unit from the roll and from the elbow 6, the next step is to remove the circlip 21 to allow the compression spring 16 to relax by expansion which expels the retainer 20 from the housing bore enlargement 10. The sleeve 3 can then be withdrawn by pushing it in the rightward direction through the housing, as viewed in the drawing, and then once the sleeve 3 has been completely removed it is possible to prise out the forcefitted seal 9 with a sharp implement. If desired, the bushing 4 may also serves simply to provide some low-friction rotational support for the sleeve 3 and thus some degree of wear of the bushing 4 will be acceptable since the sealing action is all derived at the concave surface 11 of the annular seal 9 and at its external cylindrical surface through the agency of the 0-ring seal 14.

Upon reassembly with a new annular seal 9, it will normally be desirable to replace the 0-ring 14, the spring 16, and the thrust rings 17 and 18 in case these have suffered in any way through corrosion by prolonged exposure to the coolant medium, for example water, flowing through the sleeve 3 and the roll.

The reassembly operation is then completed by inserting the sleeve 3 back into the housing 2, through the enlargement 10 in the bore thereof, to bed against the concave surface 11 of the new annular seal 9, and then the spring 16 and retainer 20 are placed in position and the retainer 20 held in against the resistance of the spring 16 (using a special tool if this proves necessary) until circlip 21 has been replaced at which time the entire rotary joint 1 is ready for replacement in the roll, using thread sealing compositions (if necessary) on the tapered threads 7.

As indicated above, a certain degree of swivelling of the sleeve 3 relative to the housing 2 is possible by virtue of the cooperating part-spherical concave and convex surfaces 11 and 12, respectively, of the annular seal 9 and enlarged portion 13 of the sleeve 3 and consequently it is acceptable for some wear of the bushing 4 to occur. Likewise, the bead 5 at the lefthand end of the housing 2 has its internal diameter chosen such that it will serve adequately to support the bushing 4 against expulsion from the housing 2 but will at the same time allow a limited degree of swivelling of the sleeve 3 by lateral movement of the longitudinal axis of the sleeve 3 about an axis of rotation which passes through the centre of curvature of the part-spherical surfaces 11 and 12.

It is an important feature of the present invention that the spring 16 presses the sleeve 3 against a seal 9 which is held non-rotatably in the housing 2. The holding of the seal 9 captive in the bore enlargement 10 of housing 2 is achieved by the force-fitting of the seal 9 in the housing. This feature of having the external cylindrical surface of the annular seal 9 stationary with respect to the wall of the bore enlargement 10 assists in the sealing action required of the 0-ring seal 14 and ensures that there is only one leakage path for the liquid from within the sleeve 3, namely between the part-spherical concave surfaces 11 and 12 of the seal 9 and sleeve 3, respectively. The extensive area of contact of the part-spherical sealing surfaces of the seal 9 and the sleeve 3, when the seal beds down, ensures that optimum sealing effect is obtained over a prolonged life of the seal 1.

It is not normally envisaged that the retainer 20 will rotate with respect to the housing 2, but this will not matter as there is no sealing action required between the external cylindrical surface of the retainer and the wall of the housing bore enlarge-

and 18 will accommodate the necessary slipping with respect to the spring 16 in order to allow rotation of the sleeve 3 with respect to the housing 2.

Although in the preferred embodiment the housing 2 is rotatable and the sleeve 3 stationary, it is of course possible for the alternative situation to arise where the housing 2 is the stator and the sleeve 3 is the rotor.

CLAIMS

1. A rotary joint comprising a housing; a sleeve disposed within said housing and supported so as to permit relative rotation between the housing and the sleeve about the longitudinal axis of the sleeve; an annular seal disposed within said housing and held against rotation with respect thereto, said seal having a concave part-spherical internal surface; a part-spherical convex external surface on said sleeve positioned to engage with said part-spherical concave surface of the seal and having substantially the same radius of curvature; means for connecting an end of said sleeve to a first conduit; means for connecting said housing to a second conduit; and means resiliently urging said sleeve for axial movement with respect to said housing in a sense which presses said part-spherical convex surface of said sleeve into firm contact with the part-spherical concave surface of said annular seal.

2. A rotary joint according to claim 1, wherein the seal has a cylindrical external surface seal with respect to a conforming cylindrical internal surface of said housing by means of a yieldable sealing member.

3. A rotary joint according to claim 2, wherein said yieldable sealing member is an O-ring.

4. A rotary joint according to any one of claims 1 to 3, wherein said resilient means urging said sleeve comprises a helical compression spring abutting between a thrust surface on said sleeve and a further thrust surface carried by said housing.

5. A rotary joint according to claim 4, wherein said further thrust surface carried by said housing is formed on an annular retaining member releasably received in said housing.

6. A rotary joint according to claim 4 or claim 5, wherein said thrust surface and said further thrust surface are defined by thrust rings engaged against suitable back up surfaces.

7. A rotary joint according to claim 6, wherein said thrust rings are of hard brass material.

8. A rotary joint according to any one of the preceding claims, and including a low friction bushing in said housing for supporting said sleeve for rotation about its longitudinal axis.

9. A rotary joint according to any one of the preceding claims, wherein said annular seal is formed of a bronze-containing polytetrafluoroethylene body.

10. A rotary joint according to any one of claims 1 to 8, wherein said annular seal is formed of a carbon-based material or a polyimide-based material.

11. A rotary joint according to claim 9, wherein a molybdenum disulphide or a polytetrafluoroethylene-based composition coated thereon.

12. A rotary joint according to any one of the preceding claims, and wherein said sleeve is of stainless steel, or chromium-plated mild steel, or mild steel plated with a layer of electroless nickel.

13. A rotary joint constructed and arranged substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

14. A rotatable roll for use in a continuous casting machine and equipped at each end with a rotary joint according to any one of the preceding claims.

New claims or amendments to claims filed on 30th June 1980
Superseded claims 1 and 2
New or amended claims:-
Original claims 3 to 14 renumbered as 2 to 13 respectively and appendencies corrected.

1. A rotary joint comprising a housing; a sleeve disposed within said housing and supported so as to permit relative rotation between the housing and the sleeve about the longitudinal axis of the sleeve; an annular seal disposed within said housing and having a concave part-spherical internal surface and a cylindrical external surface which is sealed with respect to a conforming cylindrical internal surface of said housing by means of a yieldable sealing member, whereby said yieldable sealing member holds said seal against rotation with respect to said housing, but permits removal of said seal from said housing, when desired; a part-spherical convex external surface on said sleeve positioned to engage with said part-spherical concave surface of the seal and having substantially the same radius of curvature; means for connecting an end of said sleeve to a first conduit; means for connecting said housing to a second conduit; and means resiliently urging said sleeve for axial movement with respect to said housing in a sense which presses said part-spherical convex surface of said sleeve into firm contact with the part-spherical concave surface of said annular seal.

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